

# Inside Mobile WiMAX Technology

This paper presents an overview of mobile WiMAX technology and discusses the key role of spectrum analysis for ensuring reliable systems' operation and deployment.

Mobile WiMAX (Worldwide Interoperability for Microwave Access)-IEEE-802.16e-2005 standard is a 'last mile' IP based broadband wireless solution that enables convergence of mobile and fixed broadband networks through a radio access technology known as orthogonal frequency division multiple access (OFDMA) for mobility and improved multipath performance in Non Line of Sight (NLOS) environments.

Mobile WiMAX aims to provide wireless data over long distances, in a variety of different ways, from point to point links to full mobile cellular type access. Users can now take advantage of complex, IP-based data-intensive applications while traveling at vehicular speeds. The technology provides up to 70 Mbps symmetric broadband speed over 31 miles, at higher bandwidth using Multiple-in Multiple-out (MIMO) technology, without the need for cables.

Mobile WiMAX supports adaptive modulation and coding, MIMO antennas, adaptive antenna systems and Hybrid automatic repeat request (HARQ). This brings potential benefits in terms of coverage, self installation, power consumption, frequency re-use, bandwidth efficiency and good error correction performance.

OFDMA is an air interface that allows multiple users to access the wireless communication service simultaneously using OFDM principles. In OFDM, splitting of a data stream into many parallel streams increases the symbol duration (being inversely proportional to the data rate) of each stream such that multipath delay spread is only a small fraction of the symbol duration to eliminate or minimize inter symbol interference (ISI). As a result, equalization becomes easier or no

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equalization is required. OFDM can not only be used as a modulation technique but also as a multiple access technique. These two unique features make OFDM the choice of modulation techniques for 4th generation wireless systems.

The key factors that influence the success of wireless networks include the availability of spectrum, equipment performance, equipment cost, infrastructure costs and customer penetration and deployment. In addition, conditions or restrictions on how spectrum can be used efficiently will play a role in the success of new wireless technologies. The implementation and deployment of advanced technology networks like mobile WiMAX requires accurate measurement of channel response, interference, frequency re-use, etc. As a result, it is essential for vendors to choose the right signal generation and analysis tool for designing and developing mobile-WiMAX devices. Proper selection of WiMAX field test equipment is essential for verifying standard-based RF measurements, compliance testing and for network operators to provide reliable and optimized services by proper network planning and mobility management.

To deploy a base station (BS), the engineer has to complete a site survey to verify signal quality and amount of interference

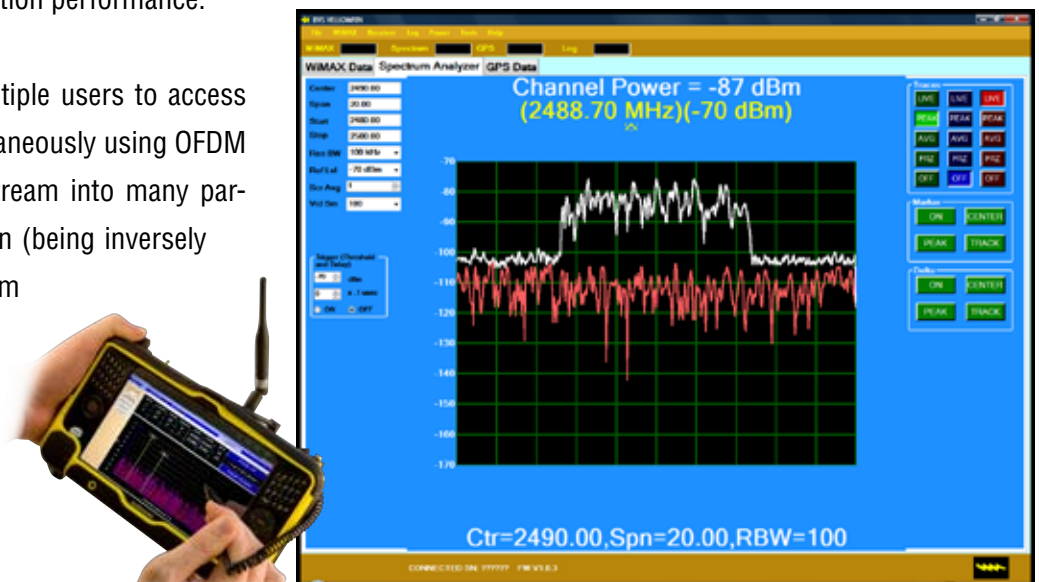


Figure 1. OFDM spectrum analysis using BVS' YellowFin™ WiMAX Analyzer

within the assigned frequency band. Signal spectrum and the EVM measurement can be used to measure the signal quality in the sub channels. Interference of neighboring BS using the same frequency in the survey area must be minimized or else two different technologies in the same band may degrade the system performance considerably. By analyzing the data spectrum of the received signal as shown in the Fig. 1, (utilizing the advanced packet Trigger Mode) the engineers are able to identify and eliminate potential interference issues before the installation of WiMAX base stations. Then, by using direction finding antennas, engineers can pinpoint sources of interference and nearby hackers.

Limited spectrum availability and increasing demand for data and multimedia resulted in frequency reuse to support vast population. It is possible to operate WiMAX systems with a universal frequency re-use plan, but doing so can cause severe outage leading to interference, particularly along the intercell and intersector edges. To mitigate this, WiMAX allows for coordination of sub channel allocation to users at the cell edges such that there is minimal overlap. This allows for a more dynamic frequency allocation across sectors, based on loading and interference conditions, as opposed to traditional fixed frequency planning for analog, CDMA and GSM. Users under good carrier to interference noise ratio (CINR) conditions will have access to the full channel bandwidth and operate under a frequency reuse of 1. Those in poor CINR conditions will be allocated nonoverlapping subchannels such that they operate under a frequency reuse of 2, 3, or 4, depending on the number of nonoverlapping subchannel groups that are allocated to be shared among these users. This type of subchannel allocation leads to the effective reuse factor taking fractional values greater than 1. The variety of subchannelization schemes supported by WiMAX makes it possible to do this in a very flexible manner. A more complex algorithm is needed for bin (defined by frequency and time) allocation of course. The downside is that cell edge users cannot have access to the full bandwidth of the channel, and hence, their peak rates will be reduced.

The ultimate goal of any wireless communication is to decode the

received signal with minimum probability of error. This can be achieved only if the signal falls into the acceptable CINR range. Spectrum of the received signal allows evaluation of CINR for different frequency reuse factors and hence the capacity of a Base Station.

OFDM is well suited for high rate broadband systems that operate in multipath environments and is considered a promising candidate for future generation cellular systems. Powerful measurement methods such as spectrum analysis helps RF Engineers and device manufacturers to characterize signals and interference. Network operators use this method to measure critical parameters like CINR and frequency reuse factors to enhance system or network performance at both pre and post deployment stages.



*BVS is a member of both the WCAI and GDC. The WCAI Global Development Committee (GDC) is for international broadband wireless operators of significant scale to research the global regulatory environment, work towards providing greater global spectrum harmonization (including freedom from interference), and discover innovations and greater efficiencies. The GDC aims to bring together existing global resources in order to develop practical applications and working models for interoperability in broadband wireless spectrum bands internationally. These include roaming agreements, and economies of scale in equipment and similar costs.*



*Berkeley Varitronics Systems (www.bvsystems.com) has been providing advanced wireless solutions and products to the domestic and international wireless telecommunications industry for over 35 years. Since 1995, BVS has introduced over 50 unique wireless test devices for a variety of applications including the popular Cellular, iDEN, PCS, CDMA, RFID, WiMAX, 802.11b/a/n/g & Bluetooth specifications.*

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